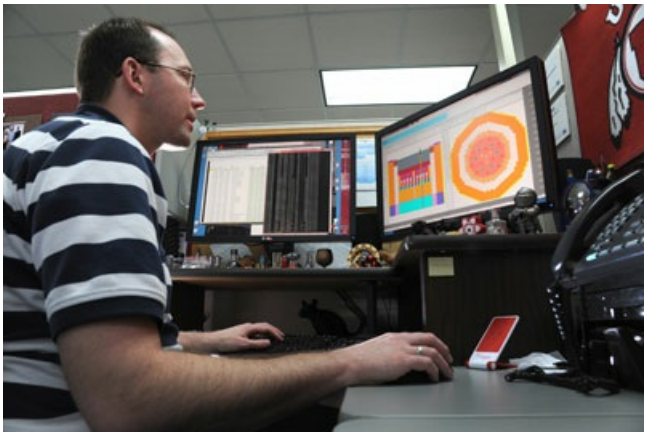


INL nuclear engineer John Bess helped perform INL's portion of an advanced reactor analysis, which was a collaboration with Argonne National Laboratory and France's Atomic Energy and Alternative Energies Commission.

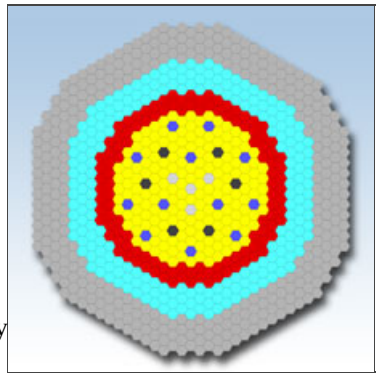
French nuclear designers tap American expertise

By Nicole Stricker, *INL Communications & Governmental Affairs* and Angela Y. Hardin, *Argonne Communications, Education and Public Affairs*

The world's nuclear experts have reached out to U.S. Department of Energy engineers for help evaluating a new nuclear reactor design that could increase safety margins while reducing waste.

The project marked a series of firsts for nuclear engineers on both sides of the Atlantic. They fostered a new collaboration and tapped state-of-the-art analysis tools to evaluate a first-of-a-kind reactor design.

France's Atomic Energy and Alternative Energies Commission (CEA) collaborated with nuclear engineers at DOE's Idaho National Laboratory and Argonne National Laboratory for the project. Its goal: assess safety and performance parameters for a new fast reactor design. The effort used cutting-edge analysis tools, and the findings verified French predictions while highlighting where to focus future efforts.



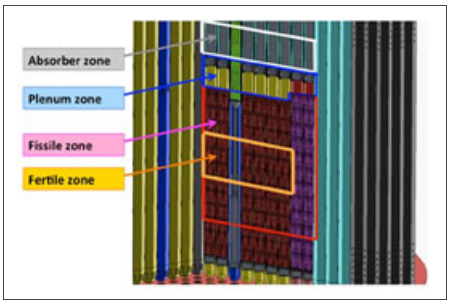
France's Advanced Sodium Technological Reactor for Industrial Demonstration (ASTRID) fast reactor design.

"We have tools and data today that we didn't have 15 years ago," said INL Fellow Giuseppe Palmiotti, who led the lab's contribution. "Plus, this enabled young American engineers to evaluate a unique design with a promising outlook."

Hussein Khalil, director of Argonne's Nuclear Engineering Division, added, "Enhancing safety is a key priority for future-generation reactors, and international collaboration is very beneficial for establishing safety criteria and verifying that new reactor designs meet or exceed these criteria."

As the country with the largest percentage of its electricity supplied by nuclear energy, France has long boasted a wealth of nuclear expertise. Now France's public atomic energy commission is working with reactor vendor Areva to design and build a new prototype for an advanced (Generation IV) sodium cooled fast reactor. Électricité de France (EDF), the world's second largest utility company, is also involved with the project.

The Advanced Sodium Technological Reactor for Industrial Demonstration (ASTRID) is intended to significantly improve resource utilization, potentially produce less radioactive waste, and increase safety margins compared to current technology. The fast reactor design offers inherent protection because the fission process would actually slow down naturally even if the reactor shutdown capability is lost — the dedicated passive decay heat removal systems would keep the reactor core cool. But before such a reactor can be built, those safety assumptions need to be checked and rechecked. That's where the DOE national labs come in.



The ASTRID design includes passive safety systems and a fuel design that would naturally slow the fission process if reactor shutdown capability was lost.

CEA partnered with DOE to have two national labs independently analyze the reactor core performance parameters and safety characteristics under defined scenarios. INL evaluated reactor physics — how neutrons behave in the reactor core during operation — using its latest data set describing neutron cross sections, as well as its state-of-the-art analysis codes. INL supplied this information to Argonne analysts, who evaluated safety margins under specific loss-of-flow and loss-of-heat-sink scenarios.

While U.S. national lab engineers performed their analyses, French engineers at CEA did the same. Each team used its own suite of codes and unique neutronics cross-section data, which are built from varied assumptions.

"Neutronics cross sections have a very complex structure," said INL's Palmiotti. "Everyone has different numbers."

Yet blind comparison of the independent French and American analyses showed agreement, bolstering confidence in the safety predictions.

"Assessment of how a reactor would behave during very unlikely and challenging accident scenarios is crucial during an early design stage – so that the safety is 'built into' the design and not 'added on' later, driving up cost and complexity," said Tanju Sofu, who led the Argonne safety analysis contribution.

The dual analyses also revealed areas requiring more design attention and the need to perform experiments in order to reduce uncertainties. Future collaborations could clarify assumptions made by each side, reduce uncertainties and possibly improve the reactor design from both the economic and safety point of view.

"We hope to continue to refine these analyses," said INL Chief Scientist Phillip Finck. "This is the first time a reactor like this might be designed and built. The French don't currently have any operating fast reactors, but they want to build a new one as part of their national energy policy to extend nuclear energy resources."

(Posted March 25, 2013)

Feature Archive